EXAMPLE 2-006
Nonlinear Analysis of a Steel Frame under Lateral Loads.

1. EXAMPLE DESCRIPTION

Figure 1 shows a steel frame that is subjected to an in-plane lateral loading at one of its corners (upper-left corner) [Ref. 1]. The frame columns are totally fixed to a bottom beams as shown in Fig. 1.a. The geometry, the dimensions, the element sections and the loading pattern are shown in Fig. 1.a.

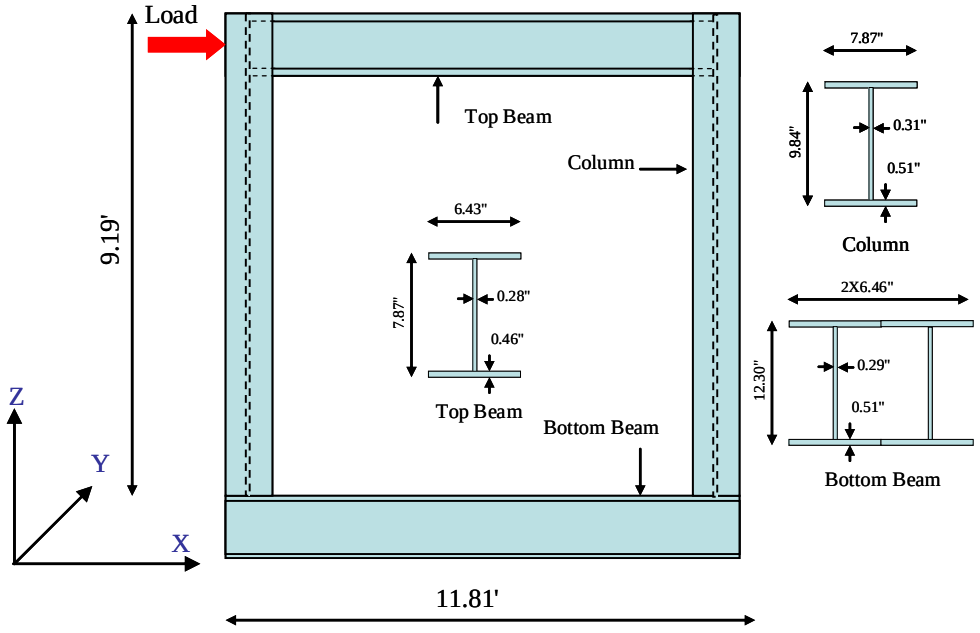

Fig. 1.a Problem geometry.

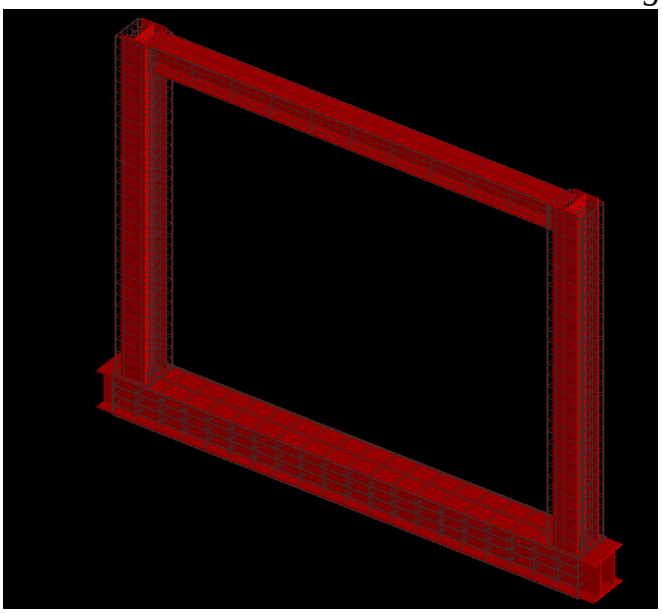

Fig. 1.b ELS mesh.

As shown in Fig. 1.a, load is applied in the frame plane (plane XZ). Displacement control load is applied till a value of 8 inches. The bottom beam is fixed to the ground at four locations. Fig. 1.b shows the mesh in ELS® software. Columns are subdivided into 4x4 elements in section and into 30 elements along the height. Top beam is divided into 2x10x4 elements and bottom beam is divided into 2x20x4 elements.

2. MATERIAL PROPERTIES

The steel yield stress is 34 ksi (0.24 kN/mm^2) and the young's modulus is 28777 ksi (196.2 kN/mm^2).

The applied element method follows a discrete crack approach, in which, the material is represented by a group of springs located at the surfaces of the element. The springs represent the axial and shear behavior of the material. For more details about material constitutive models refer to the ELS® technical manual.

3. RESULTS

Figure 2 shows the stress contours for the model solved by ELS®. Figure 3 shows a comparison between load-displacement curves for both experimental results and ELS®. A good agreement can be obviously noticed.

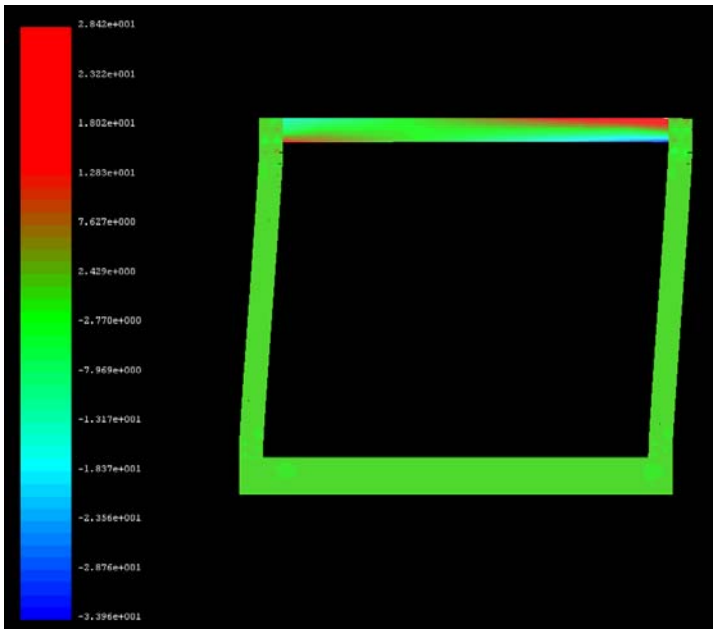

Fig. 2.a Normal stress in x-direction at applied load 25.7 kips (at output frame 301)

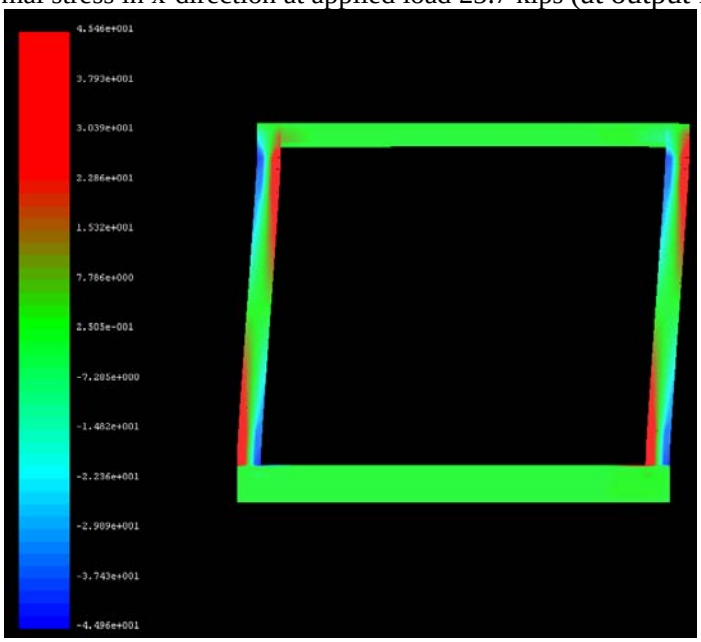

Fig. 2.b Normal stress in z-direction at applied load 25.7 kips (at output frame 301)

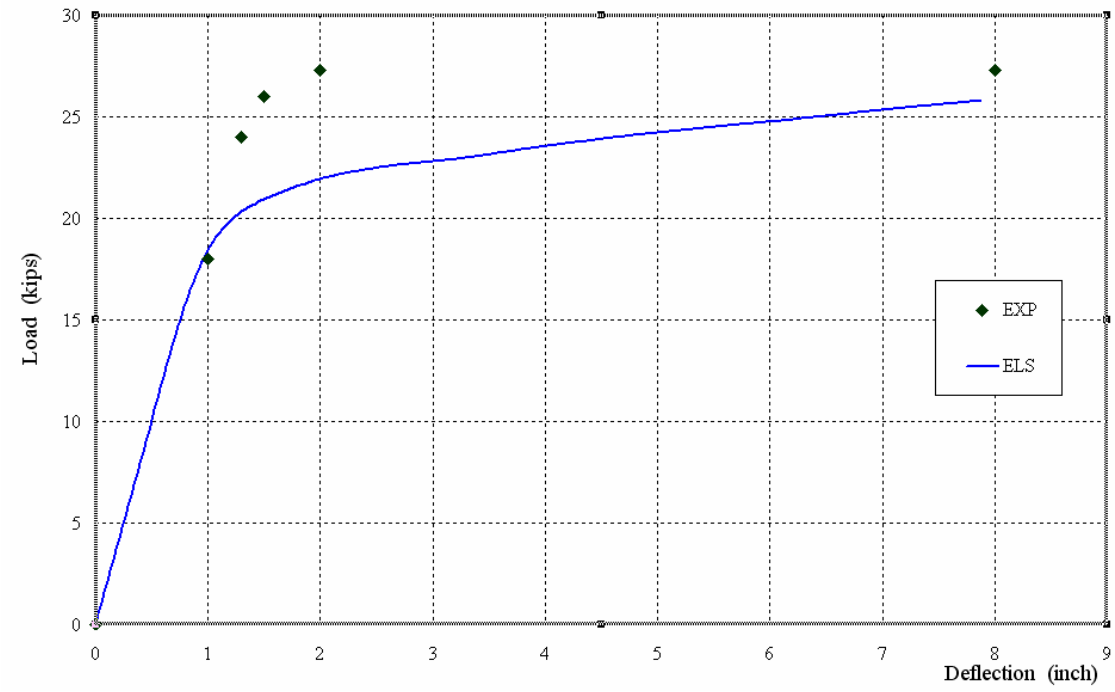

Fig. 1 Load-displacement curves comparison between ELS® and experimental data.

4. CONCLUSIONS

Based on the comparison between the experimental results of a real test and the obtained numerical results of ELS®, it can be concluded that the ELS® can accurately model the behavior of steel structures.

5. REFERENCES

1- Richardson, J. (1986), "The behavior of masonry in filled steel frames', M.Sc. Thesis, University of New Brunswick, Fredericton, N.B., Canada.

2- Technical Manual of Extreme Loading for Structures.